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Increasing power-efficiency of a micro-machined pump transducer for a parametric transmitting array in air

Haksue Lee and Wonkyu Moon
Postech, San 31, Hyoja-Dong, Namgu, 790-784 Pohang, Republic of Korea

Parametric array applications in air, such as high directional loudspeaker system, have been studied with a large radiator (generally D≥300mm) to generate high intensive sound beams required for nonlinear interactions. However, conventional transducer requires high electrical power because its electro-acoustic efficiency is too low due to an acoustic impedance mismatch. For mobile applications, a high efficient transducer is required. As an alternative pump transducer, a feasibility of a micro-machined ultrasonic transducer is studied. The efficiency can be improved by applying a thin-film membrane, overcoming the impedance mismatch. The efficiency of micro-machined transducer is simulated with a reduced dynamic model and compared with that of a conventional transducer. Two types of unimorph piezoelectric micro-machined ultrasonic transducers are designed and fabricated as small pump transducers for a ranging sensor and a loudspeaker. The electro-acoustic efficiency and dynamic characteristics related with primary wave generation are mainly examined in this work. The radiation characteristics, directional beam patterns and axial pressure distributions, of primary and secondary waves are also measured and compared with theoretical results. Throughout this work, feasibility of the proposed pump transducer is shown, but further work is also required for practical applications. [Research supported by MRCnd and ADD-UD070054AD of DAPA]